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THE AELURODON SAEVUS GROUP

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The holotypes of the species of *Aelurodon* consist almost exclusively of jaws, maxillaries, or fragments thereof. Some (*A. ferox, A. meandrinus, A. brachygnathus, A. wheelerianus*) are based upon inadequate specimens and their specific status cannot be determined. The characters that have been considered as diagnostic for the various species are those of general size, relative size and massiveness of teeth, and general proportion. While differences in these characters do exist between the specimens described as representative of distinct species the assumption that the differences are of specific significance has been based upon purely subjective evidence.

The known species of *Aelurodon* fall clearly into two quite distinct groups. One of these is represented by the types of *saevus, haydeni, inflatus,* and *mortifer* and the other by the type of *taxoides* and a number of specimens referred to *wheelerianus.* The *taxoides* group is readily distinguished from the *saevus* group by the following characters: (1) Horizontal ramus not tapering anteriorly, symphysis deep, (2) premolars little reduced, (3) heel of M_1 short, (4) entoconid of M_1 much reduced, (5) paraconid, metaconid and entoconid of M_2 reduced. Actually the differences here are so great that there seems to be sufficient justification for the separation of the *taxoides* group as a distinct genus.

In the collections of Field Museum are several jaws that are referable to the *saevus* group of *Aelurodon.* These specimens are from two fossil quarries, one at Big Spring Canyon, South Dakota, and the other near Ainsworth, Nebraska. As nearly as can be determined from associated mammals the two deposits are of equivalent age. The morphologic range among the specimens seems superficially

to be extensive. In size and general proportions they range from that of the holotype of *A. saevus*, one of the smallest and earliest of species, to that of the type of *A. mortifer*, one of the larger species. Two specimens from Big Spring Canyon—specimens that in all probability represent the same local population—differ considerably more in some respects than do types of supposedly distinct species. These facts naturally create some doubt concerning the validity of several of the described species.

In dealing with an extinct phylum such as *Aelurodon*, in which few specimens are known, and those from scattered localities, there is no direct way of determining the range of morphologic variation within a species. If, however, the range of variability is known in a related group of the same size, the variations that might be expected can be determined. At least this kind of comparison offers objective evidence that is considerably more than guess work. Thus, the use of the wolf,[1] *Canis lupus*, as a standard in assessing the taxonomic significance of characters in species of *Aelurodon* is justified because the wolf is closer in genetic relationships and size than any other species whose morphologic range can be reasonably well estimated.

Fortunately nearly every character that has been used to distinguish the species of *Aelurodon* is measurable, and quantitative comparison is therefore possible. Measurements of a series of characters of various species of the *saevus* group whose types are lower jaws are here compared with homologous measurements of specimens of the single species *Canis lupus*. The variants compared include nearly all of those that have been used for diagnosis of the various species.

The specimens used are as follows:

Type *A. saevus;* Niobrara River
Type *A. mortifer;* Snake Creek, Nebraska
Type *A. inflatus;* Big Spring Canyon, South Dakota
F.M. No. 26307; Ainsworth, Nebraska
F.M. No. 26306; Ainsworth, Nebraska
F.M. No. 15800; Big Spring Canyon, South Dakota
F.M. No. 15801; Big Spring Canyon, South Dakota

If it is assumed that all of these fossil specimens represent one species, values for the coefficient of variation (V) and standard

[1] Although the wolves have at times been placed in several species, the most authoritative recent work (Pocock, 1935; Goldman, 1937) indicates that, with the exception of *Canis rufus* of the lower Mississippi basin and the probable exception of *Canis lycaon* of eastern Canada, all belong to a single species, *C. lupus*.

deviation (S.D.) should be close to those of the living form. If the values are significantly greater and no reason therefor may be found it may be assumed that more than one species is represented in the sample. The statistics for the specimens studied are as follows:

Aelurodon

Variant	Observed range	S. D.	V*
Length M_1	27.9–33.3=5.4	1.79±.43	6.0±1.6
Breadth M_1	10.9–12.6=1.7	0.63±.17	5.3±1.4
Length P_4	15.6–19.1=3.5	1.50±.43	8.8±2.3
Breadth P_4	9.3–10.8=1.5	0.56±.16	5.6±1.5
Length P_3	11.1–12.9=1.8	0.60±.17	5.0±1.3
Depth of jaw	26.9–36.3=9.4	3.33±.96	10.6±2.8

Canis lupus

Variant	Observed range	S. D.	V*
Length M_1	25.2–30.4=5.2	1.57±.30	5.65±1.0
Breadth M_1	10.0–12.5=2.5	0.74±.14	6.6 ±1.2
Length P_4	14.5–17.0=2.5	0.69±.13	4.4 ±0.8
Breadth P_4	6.8– 8.7=1.9	0.49±.09	6.2 ±1.1
Length P_3	11.7–15.1=3.4	0.87±.16	6.2 ±1.2
Depth of jaw	22.8–31.2=8.4	2.27±.43	8.7 ±1.6

*V (coefficient of variation) is calculated from the standard deviation.

The agreement here is surprisingly close in all variants except the length of P_4. The differences in the coefficient of variation and the standard deviation for the depth of the jaw are not great, considering the variable nature of the character, which is strongly affected by age, sex, and physical development of the individuals.

Ordinarily the differences in the values of the coefficient of variation and the standard deviation for the length of P_4 would indicate that the unknown sample includes more than one taxonomic unit of the same magnitude as that of the sample with which comparison is made. In this particular case, however, there is good reason to believe that the normal range in this character in a single species of *Aelurodon* was much greater than in *Canis lupus*, and that more than one species is not necessarily indicated. The three specimens from Big Spring Canyon in all probability represent a single local population. The observed range in these specimens is 2.9 mm. (15.8–18.7). This is within 0.6 mm. of the observed range for the entire sample and is 0.4 mm. greater than the observed range for the fourteen specimens of *Canis lupus*. Such high variability in this character should be expected in *Aelurodon*, because, being closely related, or ancestral, to such genera as *Osteoborus* and *Borophagus*, with highly modified P_4's, this character was in a state of

rapid change. Contrary is the condition in *Canis*, which is a long-established, conservative form with unmodified P_4.

This analysis suggests the possibility that all species of *Aelurodon* (except *A. haydeni*) whose types are lower jaws, should be referred to *A. saevus*. It does not prove that all belong with one species but does prove that on the characters so far used more than one species cannot be demonstrated.

The specimens here included in *Aelurodon saevus* range in age from Barstovian to late Clarendonian. The earlier specimens appear on the whole to be smaller than the later. It will probably be shown that there was a progressive increase in size. A population sample from the Barstovian will probably prove significantly different from a similar sample from the Clarendonian, but the gap theoretically will be filled by intergrading series from the intermediate horizons. The entire morphologic range is of about the same magnitude as is found in a comparable living species. Thus, if the extinct group is to be broken into smaller taxonomic units, the smaller ones will logically be regarded as subspecies. The entire series, then, may represent a chronocline,[1] as defined by Simpson (1943).

Aelurodon haydeni, judging from the original description and the preservation of the type, was found in the same deposits as *A. saevus*. *Aelurodon haydeni* is surely a valid, distinct species. Comparing the type of the larger form with the group of specimens here regarded as *A. saevus* we find that the breadth of M_1 and length of P_3 are significantly greater, with P values[2] of less than 0.01; the length of M_1 and the breadth of P_4 are probably significantly greater, with P values of 0.02 or less; the length of P_4 and the depth of the jaw are not necessarily significantly greater.

The principal differences between *A. haydeni* and *A. saevus* are the large size and slightly different proportions of the former. These differences correspond rather closely to those between the coyotes and wolves of today.

An interesting possibility is suggested by the fact that *Aelurodon haydeni*, as a contemporary of the smallest member of the *saevus*

[1] Prior to Simpson's first published use of the term "chronocline" (1943, p. 174) Alfred E. Emerson used the term "chronological cline" (Amer. Nat., 77, p. 102, 1943) with the same meaning. Because of advantages in using the shorter, perfectly clear single word, and with Dr. Emerson's approval, I prefer to use and help establish the paleontologically significant "chronocline."

[2] P represents the probability that "the single deviation could have been equaled or exceeded by one drawn at random from the population represented by the sample." (Simpson and Roe, 1939, p. 189.)

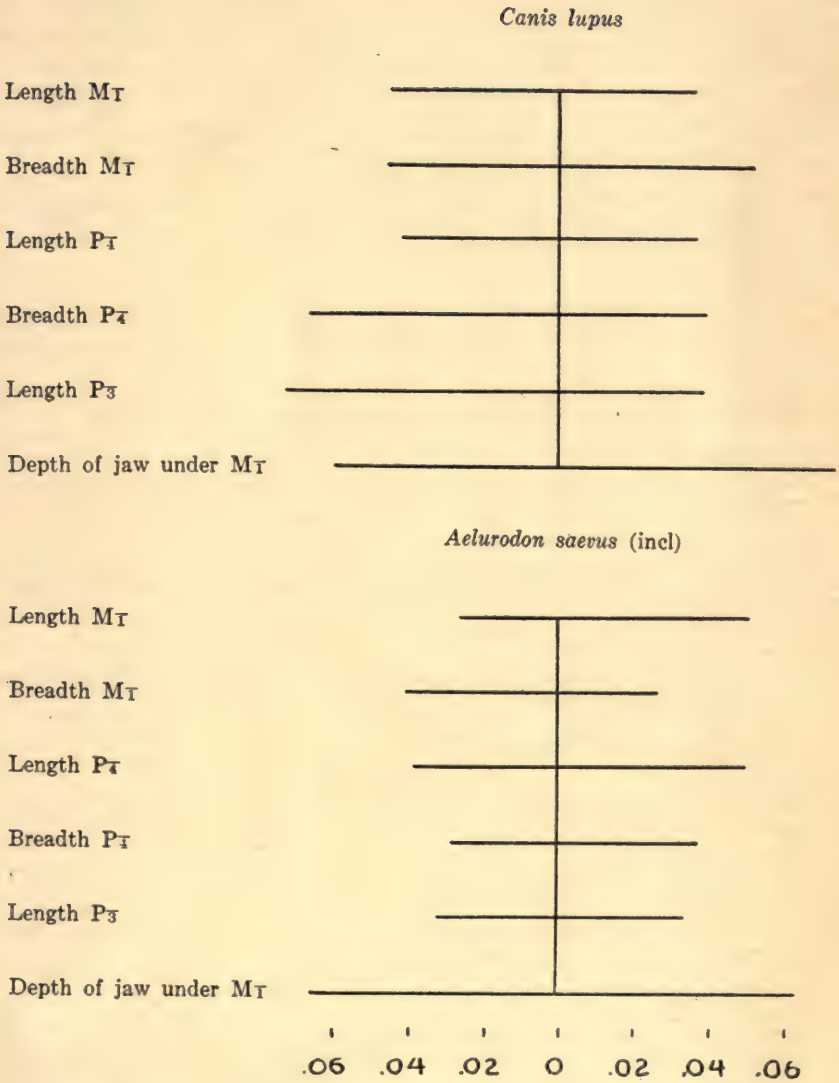

FIG. 26. Logarithmic plot showing relative range of morphologic variation in *Canis lupus* and *Aelurodon saevus* (incl.). For *Aelurodon* those specimens listed on page 80 were used, and for *Canis lupus* fourteen specimens in the collections of Field Museum. Horizontal lines show the range of variation and vertical lines indicate the mean of each character.

group, is distinguished primarily by its larger size. If *A. haydeni* had been found in deposits of later age it might be construed as a terminal member of the *A. saevus* chronocline. If a contemporary morphologic intergrading series were found connecting *A. saevus* and *A. haydeni* we would have a chorocline more or less duplicating a chronocline. Such conditions might well be found to exist in some groups when sufficient data are available.

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